
REASONABLE CONTROL MEASURES PLAN

GUIDANCE DOCUMENT AND FORMS

For Printed Circuit Board Manufacturing Industries,
Metal Finishing Industries,
and Similar Businesses

CITY OF SAN JOSÉ

ENVIRONMENTAL SERVICES DEPARTMENT

ENVIRONMENTAL ENFORCEMENT DIVISION

Cities & Agencies Tributary to the San José/Santa Clara Water Pollution Control Plant:

San José, Santa Clara, Cupertino, Milpitas, Campbell, Saratoga, Los Gatos, Monte
Sereo, County Sanitation Districts 2 & 3, Sunol & Burbank Sanitary Districts

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REFERENCES

REASONABLE CONTROL MEASURES PLAN

ABBREVIATIONS

A list of commonly used abbreviations is given below.

City	City of San José
ESD	Environmental Services Department
IU	Industrial User
MAS	Mass Audit Study
MECL	Mass Equivalent Concentration Limit
NPDES	National Pollutant Discharge Elimination System
PCB	Printed Circuit Board
RCM(s)	Reasonable Control Measure(s)
RCMP	Reasonable Control Measures Plan
R.O.	Reverse Osmosis
SMR	Self Monitoring Report
South Bay	San Francisco Bay South of Dumbarton Bridge
WPCP	San José/Santa Clara Water Pollution Control Plant
gpd	gallons per day
mgd	million gallons per day
mg/L	milligrams per liter
µg/L	micrograms per liter
ppd	pounds per day
ppm	parts per million

GUIDELINES FOR REASONABLE CONTROL MEASURES PLAN

BACKGROUND

The City of San José (City) has been charged with preserving one of the most important estuaries in the United States alongside a socially and economically complex urban community. Approximately one million residents and 16,000 commercial and industrial businesses are located within the San José/Santa Clara Water Pollution Control Plant (WPCP) service area. The City, as the agency charged with operating the WPCP according to the terms of its National Pollutant Discharge Elimination System (NPDES) permit, is responsible for limiting WPCP discharges of toxic pollutants to the San Francisco Bay South of the Dumbarton Bridge (South Bay).

In this effort, the City of San Jose and tributary areas adopted new industrial waste discharge ordinance and regulations including copper and nickel control during February, 1995. According to provisions of the ordinance:

***“Group 1 Discharger”** means an Industrial User which typically uses copper or nickel as part of its operational process and which discharges Industrial Wastes into the Sanitary Sewer System containing nickel in excess of .005 mg/L or copper in excess of .05 mg/L, and whose discharge contains in excess of .04 pounds per day (ppd) nickel or .09 ppd copper.*

***“Group 2 Discharger”** means all Industrial Users, other than Group 1 and Group 3 Dischargers.*

***“Group 3 Discharger”** means an Industrial User, other than a Group 1 Discharger, which does not typically use copper or nickel as part of its operational process, and whose average Process Flow is less than one thousand (1,000) gallons per day.*

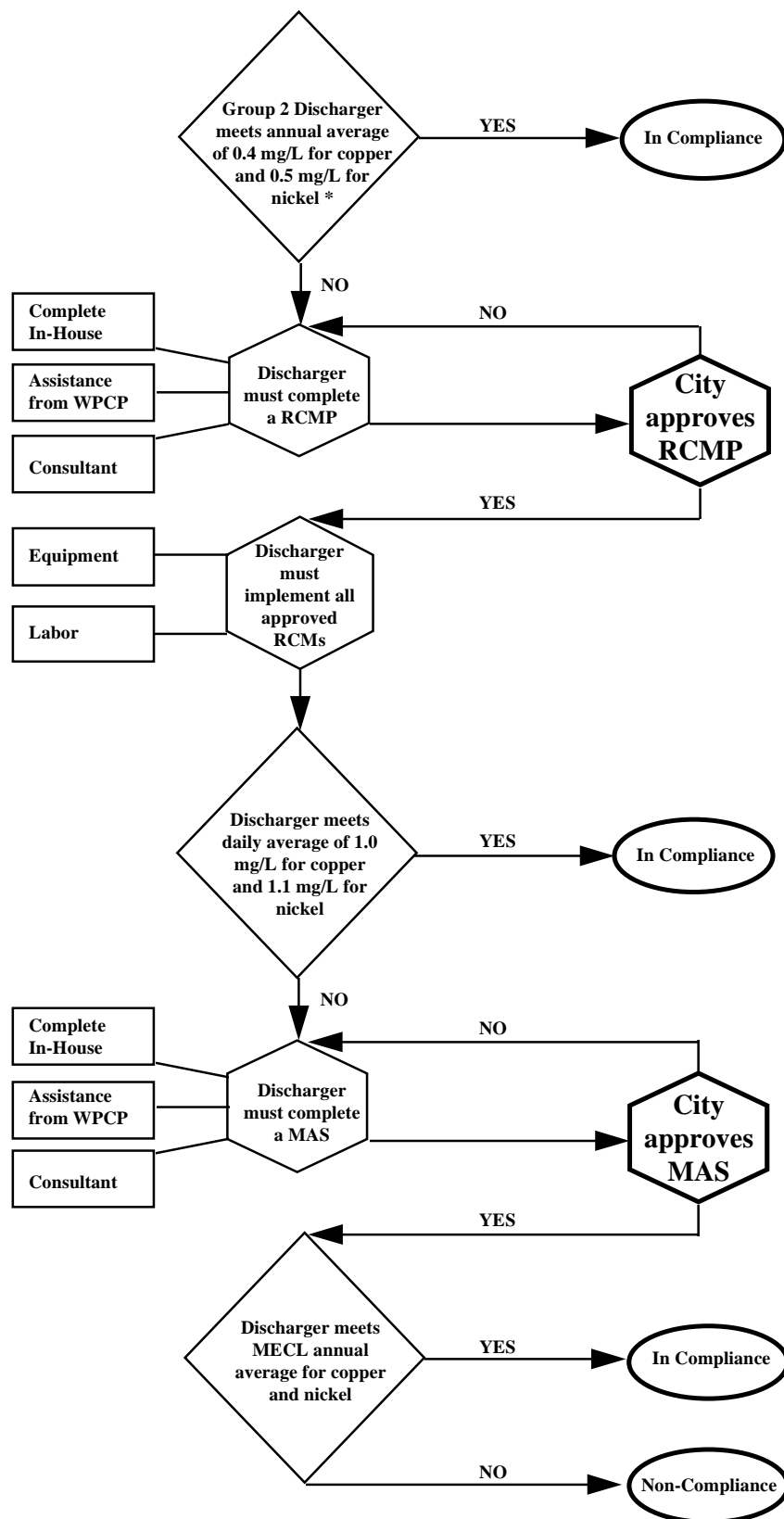
The new ordinances require Group 2 Dischargers to meet an average annual discharge concentration limit of 0.4 mg/L for copper and 0.5 mg/L for nickel. If a Discharger cannot consistently meet these concentration limits, the Discharger must complete a Reasonable Control Measures Plan (RCMP). In other words, this document is intended to be used by Group 2 Dischargers not in compliance with a discharge concentration limit of 0.4 mg/L for copper and 0.5 mg/L for nickel, as an aid in the preparation of a RCMP. This process is illustrated in the compliance flowchart on the following page.

Reasonable Control Measures (RCMs) are pollution prevention or waste minimization measures that are cost effective, which is defined as having a payback period of five years or less.

After implementing the measures in the approved RCMP, the Discharger's permit will be amended to include a daily average discharge limit of 1.0 mg/L for copper and 1.1 mg/L for nickel. All Group 2 Dischargers discharging wastewater to the sanitary sewer on or before January 1, 1995, must be in full compliance by July 31, 1997. A Group 2 Discharger unable to meet these limits will be considered to be in non-compliance and may complete a more thorough examination of pollution control measures, which is called a Mass Audit Study (MAS).

As an alternative to completing the RCMP to meet the above requirements, a Group 2 Discharger may elect to be considered a Group 1 company and complete a MAS. Thereupon, the Discharger will be issued a Mass Equivalent Concentration Limit (MECL) for copper and nickel.

FLOWCHART FOR COMPLIANCE WITH DISCHARGE LIMITS



* Group 2 Dischargers first discharging wastewater to the sanitary sewer after January 1, 1995 must have 12 months of discharge sampling data to determine average annual discharge concentrations.

PURPOSE

The purpose of this document is to provide guidance and establish the parameters for industry when preparing a RCMP. The *RCMP Guidance Document and Forms* describes the format required for a RCMP. Use existing information where possible. Sources of information include Hazardous Materials Management Plans (HMMP), SB-14 Source Reduction Plans, Waste Minimization Plans (WMP), Process Operation Records, and Original Construction Drawings. This document may be revised periodically as technology changes. For further questions regarding the contents of the RCMP or MAS, please contact your City Source Control Inspector at (408) 945-3000.

SCHEDULE OF SUBMITTAL

Group 2 Dischargers lawfully discharging industrial waste to the Sanitary Sewer System on or before January 1, 1995, shall cause their facility to be in full compliance with the Group 2 discharge conditions and concentration limits by no later than July 31, 1997. It is the responsibility of the Industrial User (IU) to determine whether or not to submit a RCMP. It is also the responsibility of the IU to ensure that the facility meets the July 31, 1997 deadline. Submittal of a RCMP should allow sufficient time for review and approval by the City, and implementation of approved measures. All IUs are encouraged to complete this process as soon as possible.

City Source Control Inspectors are continually evaluating IUs' performance data for potential non-compliance with the annual averages and the necessity to complete a RCMP. The RCMP is subject to approval by the City's Environmental Enforcement Division.

PROCEDURE FOR SUBMITTAL

1. Submit the completed RCMP within ninety (90) days of receipt. The required format and contents of the plan are described in the following section.
2. Proprietary information, as defined in the Wastewater Discharge Permit Regulations, can be kept on-site. However, a version without proprietary information will be required for the City's files. Information will have to be verified by a City Environmental Engineer or Source Control Inspector before a RCMP can be considered complete.
3. After submission of the RCMP by the facility and approval by the Director of ESD or an authorized designee, progress reports on the reasonable control measures being implemented shall be included with Self Monitoring Reports (SMRs) until all projects have been completed.

RCMP FORMAT AND CONTENTS

Prepare a RCMP that includes an evaluation of each of the industrial processes that generate wastewater at your facility. The RCMP shall include the following:

1. COVER SHEET: Complete the attached cover sheet in its entirety.
2. FACILITY BLOCK FLOW DIAGRAM: A sample facility block flow diagram is provided in Figure 1. The diagram should include the following:

- The amount of copper and nickel in the final effluent discharged to the sanitary sewer system. Include the total wastewater flow in gallons per day, concentration of pollutants in milligrams per liter, and total mass in pounds per day.

$$(*\text{Average Flow in gpd}) (*\text{Average Concentration in mg/L}) (8.34 \times 10^{-6}) = \text{lbs/day}$$

**Flow and concentration data may be obtained from your Source Control Inspector. Use the previous 12-month period to calculate averages. Calculate Non-Detects (NDs) using one half the detection limit.*

- Each process discharging industrial process wastewater.
 - The path and direction of wastewater flow. (Example: Either to batch treatment, continuous treatment, or directly to the sample box.).
 - The location of the treatment system, flowmeters, and wastewater sampling point(s). Flowmeters should be identified as influent, influent dedicated to process, or effluent. Sample points should be identified as in the permit.
3. PROCESS BLOCK FLOW DIAGRAM: For **each industrial process** in the facility block flow diagram, prepare a detailed block flow diagram. Check your HMMP for usable diagrams. Sample diagrams are provided in Figure 2 and Figure 3. The diagrams should include:
 - Each tank that discharges industrial process wastewater.
 - The direction of product work flow and industrial process wastewater flow.
 4. REASONABLE CONTROL MEASURES CHECKLISTS: This section contains four checklists categorized as:
 - I. Flow Reduction** A separate checklist must be completed for each industrial process wastestream in the facility that requires treatment prior to discharge to the sanitary sewer.
 - II. Pollutant Reduction** A separate checklist must be completed for each copper and/or nickel bearing or generating process.

III. Treatment Modifications Complete one checklist for the facility.

IV. Administrative Measures Complete one checklist for the facility.

Each RCM listed on the checklist is numbered and described in the section titled "Description of Reasonable Control Measures." In this section, measures which should be considered if appropriate, although not necessarily standard in industry at this time, are described in "Other." If a measure listed on the checklists is determined to be "Non-Applicable," a thorough explanation must be included in the comments column or on attached documentation. The comments section may also be used to discuss cost/benefit analysis and how a measure will impact processes, product quality, and waste treatment.

5. **IMPLEMENTATION SCHEDULE:** All RCMs that are applicable must either be in place or included in the Implementation Schedule. On this worksheet, list all RCMs that are planned by ID number and name as listed on the checklist. Also provide the project implementation start and completion dates in the appropriate columns.
6. **INFORMATION and IMPLEMENTATION CERTIFICATION:** The purpose of this section is to certify that the RCMP has been completed by the appropriate personnel, the obligations of the plan are understood, and that the information included in the submitted RCMP is true. The certification must be signed by both the person who prepared the plan and the Executive Officer that supervised the preparation of the RCMP.

FIGURE 1
Sample Facility Block Flow Diagram

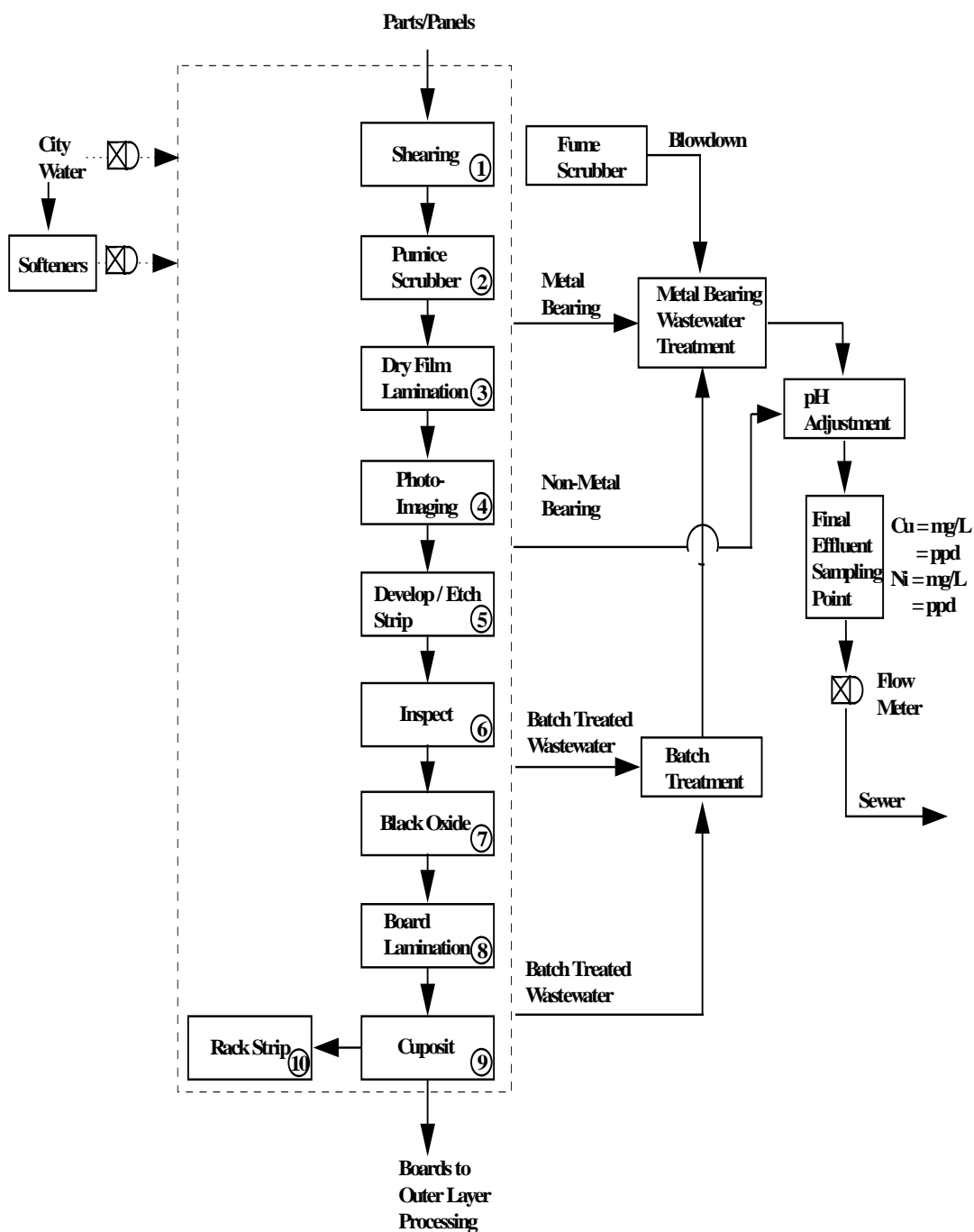


FIGURE 2
Sample Detail Process Block Flow Diagram

⑤ Develop / Etch / Strip

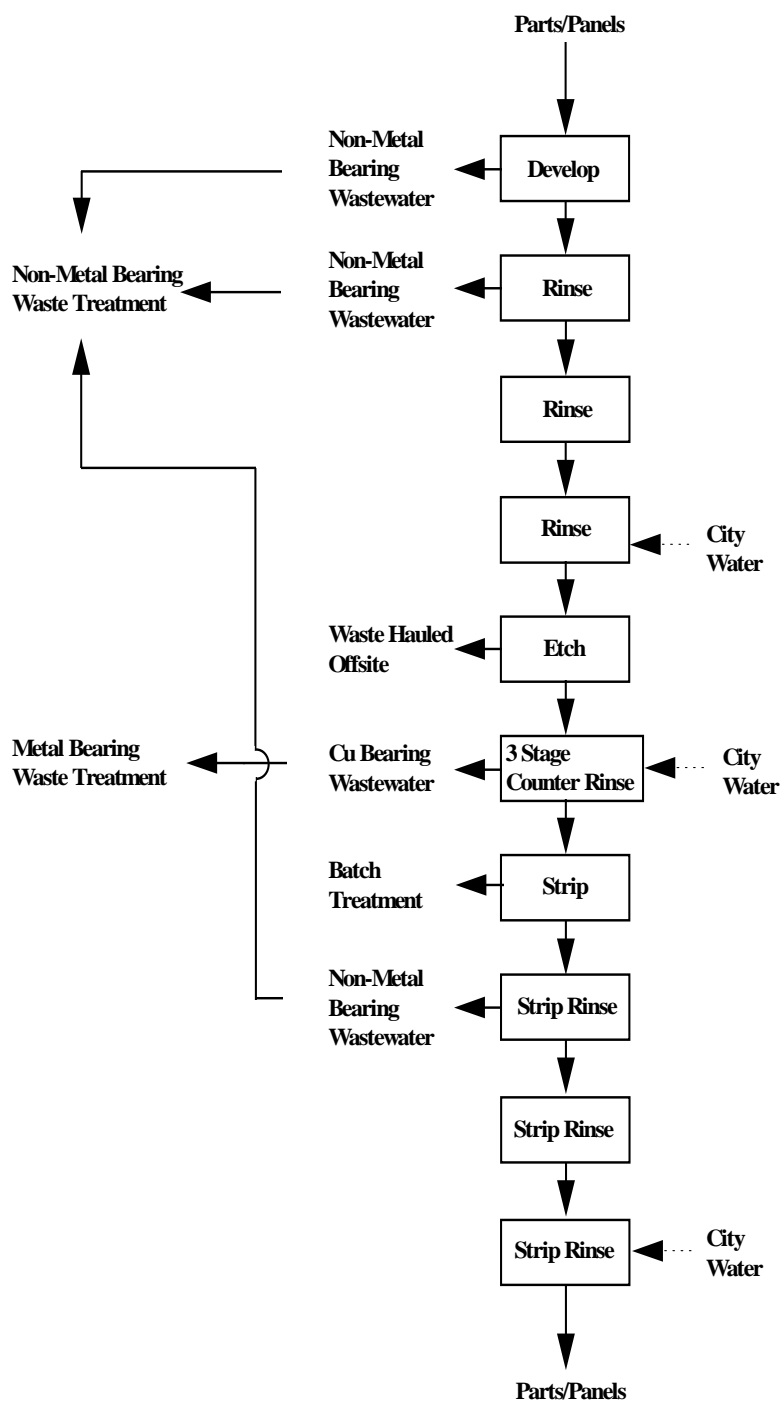
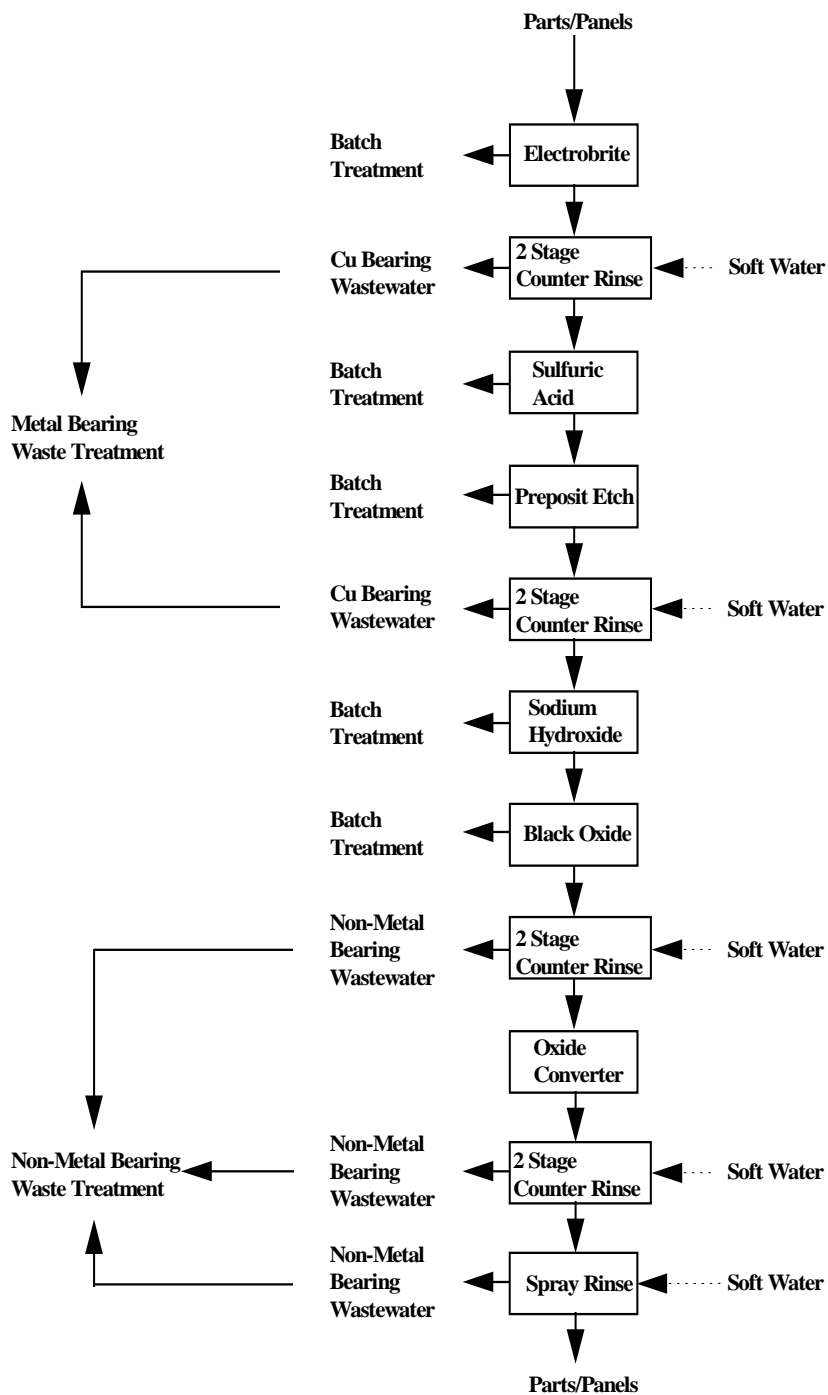


FIGURE 3
Sample Detail Process Block Flow Diagram

⑦ **Black Oxide Process**



DESCRIPTION OF REASONABLE CONTROL MEASURES

The Reasonable Control Measures document comprises four distinct categories; they are:

- I. Flow Reduction
- II. Pollutant Reduction
- III. Treatment Modifications
- IV. Administrative Measures

A checklist for each category is attached. Each category is described in the subsequent pages. It should be noted here that all of the listed RCMs cannot be implemented on the same process line in all cases. Some of these RCMs are mutually exclusive. Therefore, the facility must thoroughly evaluate each of its processes that generate a copper or nickel bearing wastestream and select the specific RCMs that are most appropriate to implement. Employee safety and housekeeping issues should also be assessed as part of considering a measure.

The use of these guidelines cannot be interpreted as protection against enforcement action. It is up to the Discharger to ensure compliance with all local, state, and federal regulations. Additionally, the City will not endorse or reject a project because of any specific consultant, vendor or product line mentioned.

I FLOW REDUCTION METHODS

Decreasing discharge flow presents one of the main opportunities for pollutant reduction for both metal and non-metal bearing wastestreams. The reduction of non-metal bearing wastestreams has a positive effect on mass loading reduction in many cases. In general, wastewater treatment equipment reaches an equilibrium, with little change in effluent concentration for a given range of influent concentration. By reducing the flow of wastewater through the treatment system, the mass being discharged will be reduced, especially if the effluent concentration remains constant. Therefore, the emphasis of the flow reduction section of this RCMP is on wastestreams that contain copper and/or nickel, or mix with such wastestreams prior to or during pretreatment. RCMs for wastestreams that discharge downstream of all pretreatment and do not contain copper and/or nickel are not required to be implemented, but must be included in the evaluation. Data must be available to show that these wastestreams do not contribute to copper and/or nickel loading to the WPCP.

Flow reduction includes practices such as reducing rinsewater discharges through reuse of rinse or treated water, and rinse agitation methods. Check with your City Source Control Inspector for information on incentive programs for water conservation. The following flow reduction measures must be evaluated for each industrial process in the facility.

I-A RINSEWATER REDUCTION

I-A1. Flow Restrictors and Manual Flow Controls

Flow restrictors limit the volume of rinsewater flowing through a running rinse system. These devices are used to maintain constant flow of makeup water into the system once the optimal flowrate has been determined. Industries often use batch process product lines in which rinse lines are manually turned on and off throughout the day. Pressure-activated control devices such as hand, knee, or foot-pedal activated valves can be helpful in ensuring that makeup water is not left on longer than necessary to maintain rinsewater quality after the rinse operation is completed.

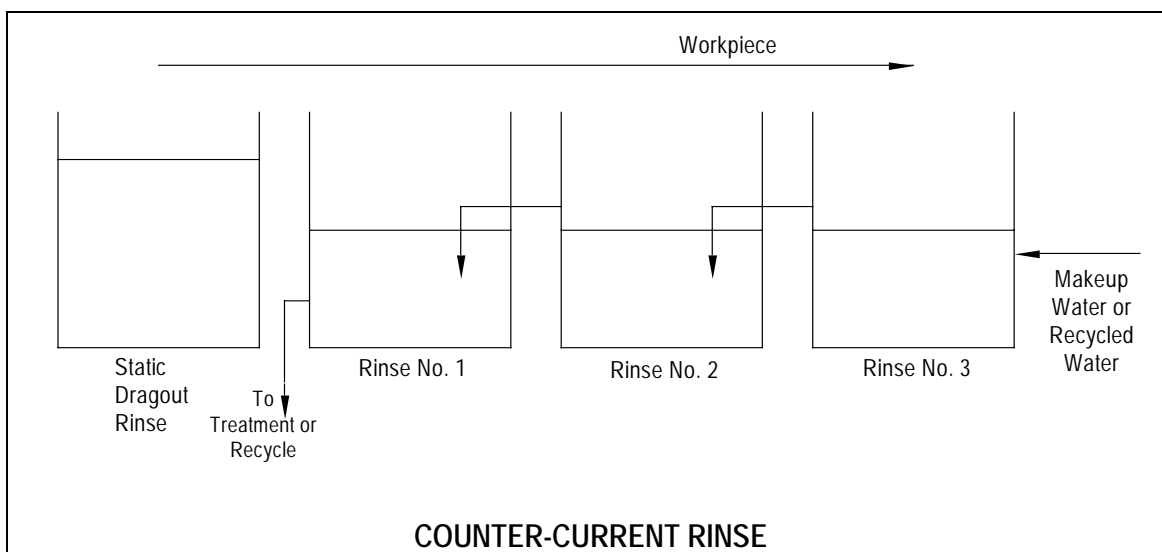
I-A2. Counter-current Rinse Systems

Multiple counter-current rinse tanks can be used to provide sufficient rinsing while significantly reducing the volume of rinsewater used. A properly designed counter-current rinse system will provide sufficient agitation. A multistage counter-current rinsing system can use up to 90 percent less rinsewater than a conventional single-stage

rinse system. Actual water savings will vary depending on the number and configuration of tanks used.

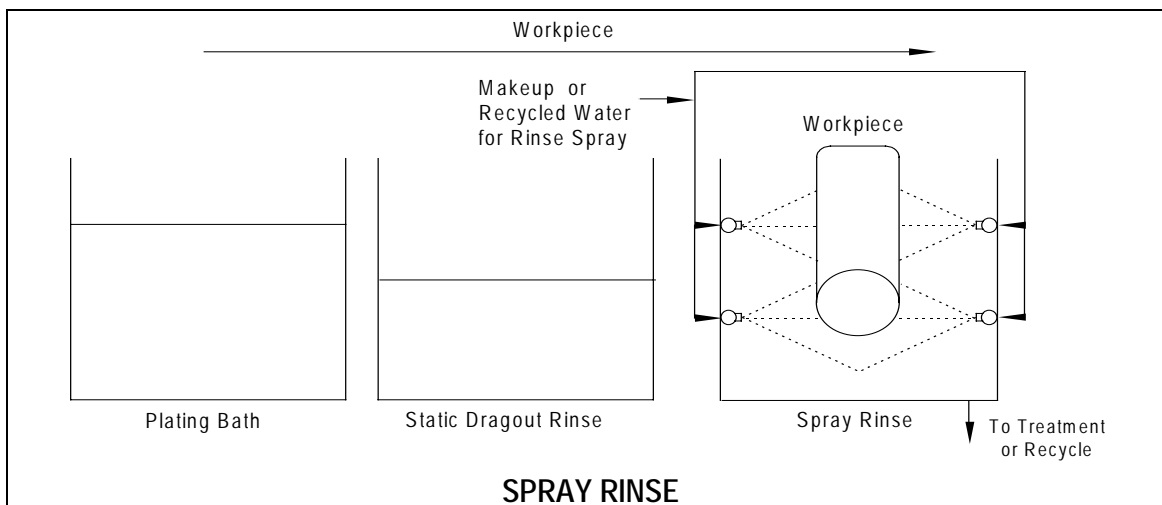
The use of a multistage counter-current rinse system allows (1) greater contact time between the workpiece and the rinsewater; (2) greater dispersion of process chemicals into a rinse solution; and (3) more rinsewater to come into contact with the workpiece. In a multi-stage counter-current rinse system, the workpiece moves in the opposite direction of the rinsewater flow. The workpiece is immersed in successively cleaner rinse tanks. Counter-current rinsing should be operated with automatic or restricted water flow controls to allow minimal wastewater flow.

The disadvantage of multistage counter-current rinsing is that more process steps are required and additional equipment and workspace is needed. If additional space is not available, the addition of multistage rinse systems may not be feasible. An option for a facility lacking floor space for additional tanks would be to reduce the size of the rinse tanks or to segregate existing tanks into multiple compartments, if workpiece size allows.



I-A3. Spray Rinse Systems

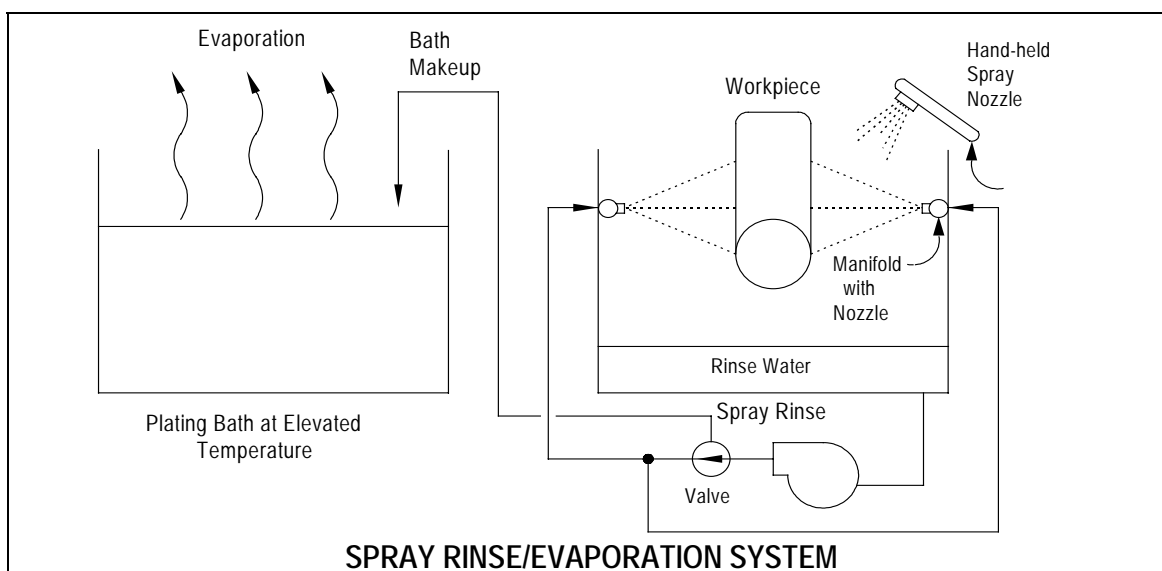
Short duration spray rinsing uses between one-eighth and one-fourth the volume of water that a continuous flow rinse uses. For simple workpieces such as sheets, spray rinsing is highly effective. For more complex workpieces, spray rinses may not reach inner cavities of workpieces. However, spray rinsing can be combined with immersion rinsing. The application of spray rinsing as a first step in a rinse cycle is effective in reducing wastewater production. Spray rinses may be actuated manually or automatically, and remain in operation for short duration for workpiece rinsing.



I-A4. Spray Rinse/Evaporation Makeup Systems

Use of a spray rinsing system with evaporative makeup is an effective water minimization technique that can result in zero discharge for process tanks that provide elevated temperatures and resulting evaporation losses. To maintain product quality, this system may need to be combined with processes such as ion exchange, electrowinning, electrodialysis, or occasional bath decant to reduce accumulation of impurities.

The system uses an empty spray rinse tank. A pump feeds spray nozzles located around the inside of the tank. The workpiece is lowered into the spray zone and the drippings fall to the bottom of the tank for recirculation. A final rinse can be done with a spray nozzle using either City water or deionized water. The used water can then be piped where needed for evaporation makeup and/or recycling. Evaporation makeup is an example of recycling that reduces waste generation.



I-A5. Oversprays/Foggers

Oversprays and foggers are variations of a spray nozzle system. Oversprays use high pressure water. Fog nozzles use high pressure air for atomization to produce a fine mist capable of greater workpiece penetration for rinsing and lower water use than for a conventional spray nozzle. It is more often possible to use an overspray or fogger rather than a spray nozzle directly over a heated plating bath to rinse the workpiece, because less water is added to the process bath using these alternatives. Often workpieces are also able to hang longer without drying out when oversprays or foggers are used. Employee safety and housekeeping issues should be evaluated when considering this measure.

I-A6. Sensor Activated Rinses

Where appropriate, a contact switch can be placed on the tank so that when racks of parts are rested in a rinse tank, the feed line water valve is opened and the rinse cycle is activated. The control circuit is set to turn off the water flow within a predetermined time period after workpieces are removed from the rinse.

I-A7. Timer Flow Controls

Timers are used with spray, continuous, and sensor activated flow rinses to shut the spray off after a predetermined period and allow only the amount of water flow necessary to rinse the parts. These controls work best when the workpiece or parts to be rinsed are homogeneous from one batch of parts to the next.

I-A8. Conductivity Flow Controls

A conductivity or pH meter can be used to control makeup water flow through a rinse system. A conductivity probe or pH cell is used to measure the level of dissolved solids or hydrogen ions in the rinsewater. When this level reaches a preset minimum conductivity or pH set point, the controller closes a valve that terminates the flow of water into the rinse system. When the concentration builds to the preset maximum level or pH set point, the controller opens a valve which initiates the flow of water. Since most metal finishers have non-homogeneous production, the level of dissolved solids in the rinse solutions will likely fluctuate. Therefore, conductivity control equipment is especially valuable to the metal finishing industry. Use of these controllers can reduce product reject rates by improving water quality. Tank contents must be mixed thoroughly in order to ensure homogeneity of the water sensed by the probe, thereby

resulting in effective operation of the water flow controller. Routine and frequent cleaning of probes may be necessary to ensure product quality.

I-A9. OTHER

The methods discussed above have been observed to have wide applicability in many, though not necessarily all, of the processes used in your industry. There are other methods observed to have limited applicability, depending on whether a process is automated, suitability of static rinses with different chemistries, and other site-specific circumstances. ESD encourages each discharger to pursue new pollution prevention measures, whether included on this list or not. This is particularly true for dischargers who indicate there are no “new” projects on the list of rinsewater reductions they can consider for any process.

I-B REUSE OF RINSE/TREATED WATER

I-B1. Use in Fume Scrubber/Cooling Towers

Effluent from a final rinse operation, which is usually less contaminated than in-process rinsewaters, can be used as makeup water for fume scrubbers and cooling towers. This rinsewater may need pH adjustment prior to using it as makeup water in fume scrubbers and cooling towers. Final effluent (effluent after treatment) can be used as makeup water for the fume scrubbers and cooling towers. Check with your City Source Control Inspector prior to implementing this measure.

I-B2. Reuse of Process Rinsewater

After rinse solutions become too contaminated for their original rinse process, they may be useful for other rinse processes. Process lines and rinsewater requirements should be evaluated so rinse system arrangements can be developed to take advantage of rinsewater reuse opportunities.

Effluent from a rinse system that follows an acid cleaning bath can be reused as influent water to a rinse system following an alkaline cleaning bath. This configuration can actually improve rinse efficiency. The neutralization reaction reduces the viscosity of the alkaline drag-out film. In some instances, unwanted precipitation of metal hydroxides onto the cleaned workpieces can occur.

Other rinsewater recycling opportunities are also available. Alkaline cleaning rinsewater effluent can be used as rinsewater for workpieces that have gone through a mild acid etch process. Effluent from a final rinse operation, which is usually less contaminated than

other rinsewaters, can be used as influent for rinse operations that do not require high rinsewater quality.

I-B3. Reuse of Treated Wastewater

Treated water may be reused as rinsewater for non-critical rinsing steps.

I-B4. OTHER

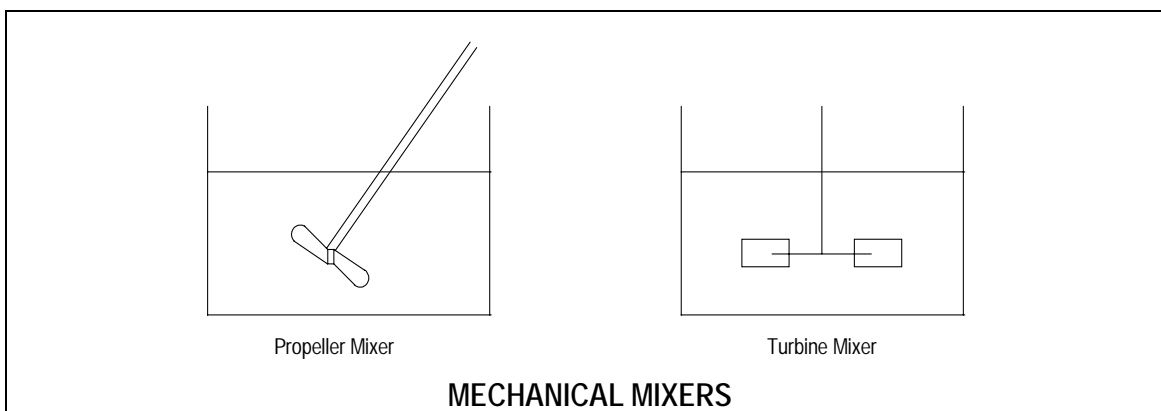
Use of Scrubber/Cooling Water in Process: The water from fume scrubbers has been shown to be suitable for rinsing in certain cases. Spent cooling water or steam condensate can also be employed for rinsing, if technically permissible and economically justified. One example is the use of scrubber water in a caustic soap rinse.

Segregation of Rinse Flows: Waste stream segregation is highly recommended, because it facilitates rinse flow reuse and material recycling. Since segregating rinse flows eliminates the mixing of non-hazardous wastes with hazardous wastes, flows are easier and less expensive to treat and dispose. Segregated acidic and alkaline waste streams allow potential recycling plant applications. Segregation of specific solvent-bearing wastestreams allows on-site recycling or off-site recovery. Segregation of metal-bearing wastewaters is important in plant operations with wastestreams containing chelated metal complexes requiring special treatment.

I-C RINSE AGITATION MEASURES

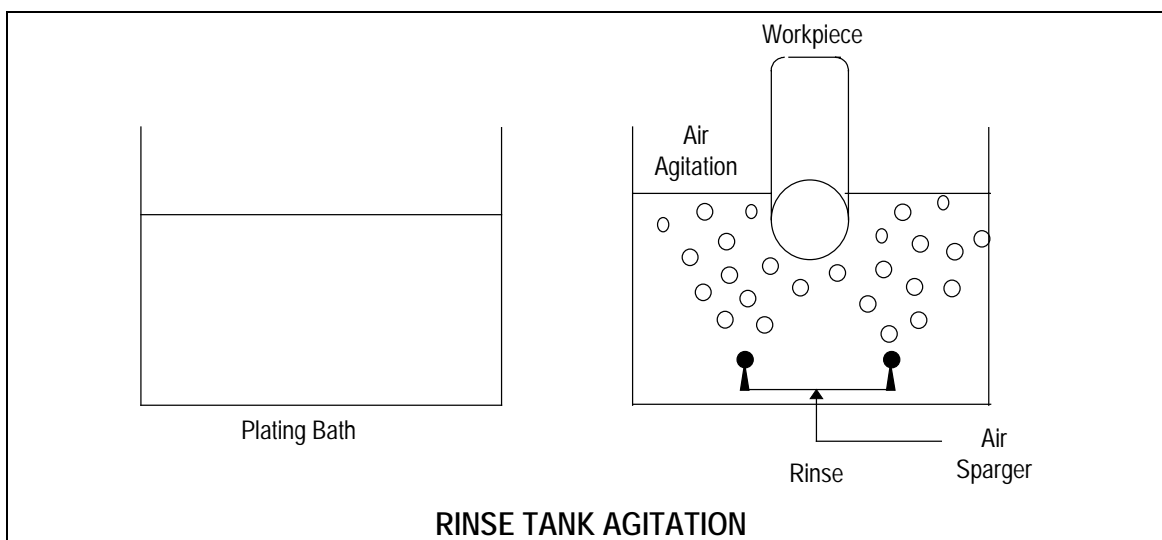
I-C1. Mechanical Mixers

The purpose of mechanical mixing, like that of air sparging, is to maintain the contents of the tank in a completely mixed state. With mechanical mixing, turbulence is induced by means of rotating impellers, such as propellers, turbines, and paddles.



I-C2. Air Agitation

The most important factor in the design of rinse systems is ensuring complete mixing of rinsewater, thus eliminating short circuiting of feed water and utilizing the entire rinse cell volume. Agitating the rinsewater by using forced air or water is the most efficient method for creating complete mixing during rinse operations. This can be achieved by pumping either air or water into the immersion rinse tank. Air agitation can provide the best rinsing because the air bubbles create improved turbulence to remove the chemical process solution from the workpiece surface. This type of agitation can be performed by pumping filtered low-pressure air into the bottom of the tank through a pipe distributor (air spargers).

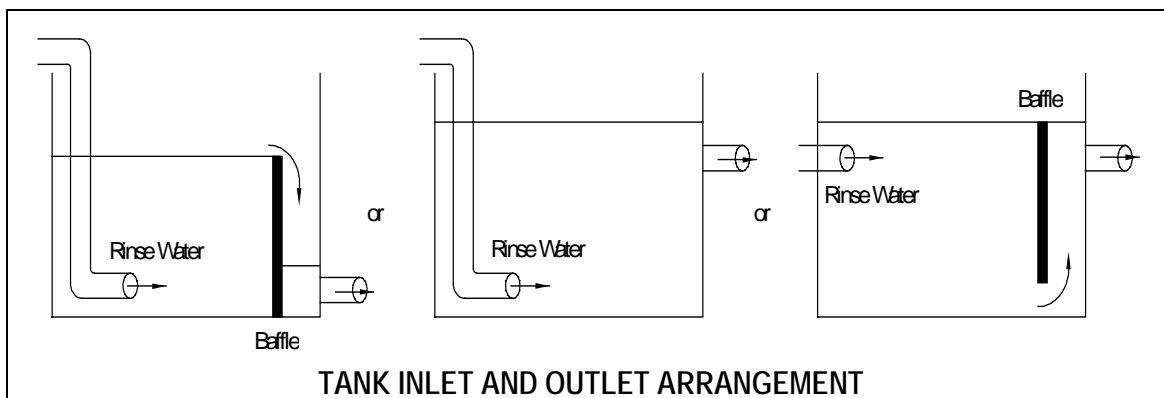


I-C3. Sonics

Rinse agitation methods, in addition to maintaining a mixed state, also provide better workpiece cleaning. Ultrasonic waves are used to create small vacuum bubbles in liquid tank contents. When these bubbles collapse, they cause a strong cleaning action on nearby parts. Ultrasonic cleaning is particularly useful for parts with hard to reach surfaces, and may allow operation at a lower temperature. Caution is advised on the use of this measure in acidic rinses.

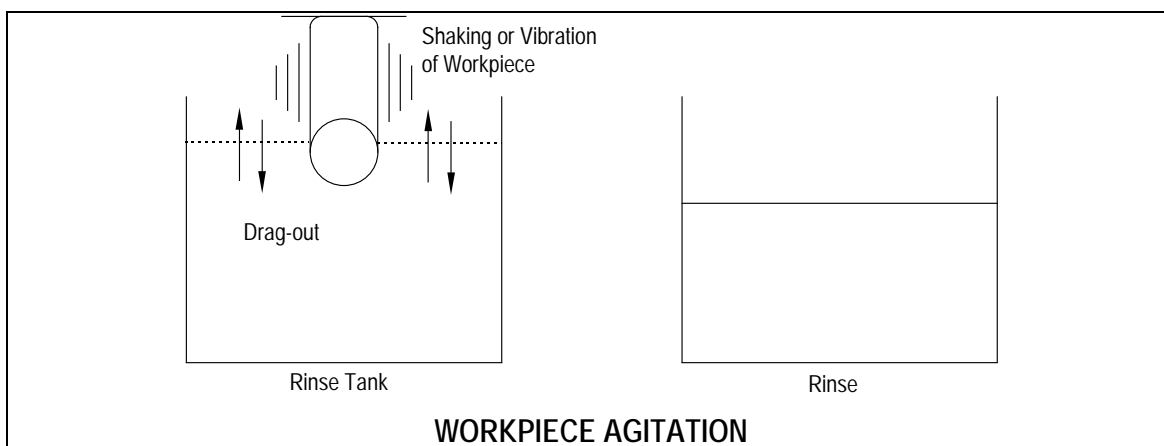
I-C4. Tank Arrangement

Tank size, shape and internal configuration should be arranged such that rinsewaters circulate thoroughly and do not “short circuit” from the inlet directly to the outlet. Be sure to arrange all piping in a fashion that would eliminate a back siphon potential. Use gravity flow where possible.



I-C5. Workpiece Agitation

If the configuration of the workpiece permits, agitation between the workpiece and rinsewater can be performed by moving the workpiece rack in the water or creating turbulence in the feed water. Since many metal finishing plants operate hand rack lines, operators could easily move workpieces manually by agitating the hand rack. Rinsing is more effective if the pieces are raised and lowered in and out of the rinse tank rather than agitating the pieces while they are submerged. The effectiveness of this system depends on proper instruction of the operator, and monitoring by the supervisor. This technique is effective for use with workpieces with large surface areas and interior surfaces that will not effectively drain.



II POLLUTANT REDUCTION

Reducing the amount of pollutants to be treated or disposed of helps facilities meet compliance limits and reduce operating costs. Pollutant reduction practices include methods such as extending bath life, using alternative chemistry, and modifying drag-out methods and tanks. **All pollution reduction measures described below must be evaluated for each copper or nickel bearing or generating process.**

II-A EXTENDING BATH LIFE

II-A1. Process Bath Filtration

Filtration systems can be used to remove contaminants that build up in process baths and shorten bath life. To avoid contamination related defects in the plating resulting in high reject rates, baths should be continuously filtered to remove impurities. Continuous filtration can extend the life of the bath, thereby reducing the waste produced by treating spent process baths. Filters should be sized and operated according to manufacturer's specifications. When organic build up is a problem in baths, use of carbon filter cartridges is appropriate.

II-A2. Process Bath Replenishment

Process bath effectiveness is diminished by depletion and contamination. Chemicals essential to the process are depleted by plating and are removed as drag-out on workpieces. Contaminants are introduced into the bath when workpieces are not completely rinsed from previous baths and from airborne sources. Replenishment by decanting the bath is one option that should be considered before discarding the bath. When the entire effectiveness of the bath falls off, part of the bath can be decanted and discarded and fresh water and chemicals can be added to replace the decanted portion. Decanted portions from the baths may also be appropriate to use for waste treatment.

II-A3. Frequency of Bath Changes

Frequent bath analysis can extend the bath life by determining the necessary replenishment chemistry needed to keep the bath within the manufacturer specification. Extending bath life results in less waste to be treated and/or hauled off-site.

II-A4. OTHER

Electrolytic Bath Purification: Electrolytic bath purification is used to remove trace metal impurities. The process requires placing an anode and a cathode in the rinse solution. As current passes from anode to cathode, the metallic impurities deposit on the cathode along with the plating metal. The metallic deposit can be reclaimed or sold as scrap metal.

Chemical Treatment: Chemical treatment usually involves the addition of oxidizing agents which “strip” the organic brighteners from a bath. New chemistry can then be added to replenish the bath.

Physical Treatment: This includes chilling the bath to precipitate out insoluble impurities such as carbonates.

II-B NEW CHEMISTRY/MANUFACTURING

II-B1. Alternate Chemistry

The use of alternate chemistry can modify process parameters to extend bath life beyond normal bath discard criteria. Some process chemicals which are considered hazardous waste when spent, can be replaced with chemicals that can be treated or recycled on-site. This can reduce waste management costs.

II-B2. Less Chelated Chemistry

The use of non-chelated or less chelated process chemicals in baths can reduce hazardous waste generation. Chelators are used in chemical process baths to allow metal ions to remain in solution beyond their normal solubility limit. Chelators are usually found in baths used for metal etching, cleaning, and selective electroless plating. Once the chelating compounds enter the wastestream, they inhibit the precipitation of metals because the chelating agent will not precipitate, and additional treatment chemicals must be used. These treatment chemicals end up in the sludge and contribute to the volume of hazardous waste. In addition, many of the spent process baths containing chelators cannot be treated on-site and are containerized for off-site disposal, adding to waste disposal costs. Non-chelated process chemistries can be used for many cleaning processes. It is unnecessary to keep metals in solutions that have been removed from workpiece surfaces during cleaning and etching. Those metals can be allowed to precipitate, and the process bath can be filtered to remove solids.

II-B3. Evaporation to Concentrate Wastes

Evaporation has been successfully used in a number of ways to recover plating bath chemicals. In one technique, static rinsewater is evaporated to reduce its volume sufficiently to allow the remaining concentrate to be returned directly to the process bath. In another technique, it is the water from the process bath that is evaporated, making room in the bath for rinsewater to be added as makeup. The water vapor can be condensed in some systems and reused in the rinse system.

II-B4. OTHER

Process Automation: Computerized process-control systems can be used for parts handling and process bath monitoring.

Double-treat Core for PCBs: The use of these boards by a company can be considered an RCM due to the incidental effects rather than any direct effects. PCB shops using or considering "double-treated" boards indicate that use of such boards will eliminate or reduce the need for processes like pumice scrubbing (a very significant water savings) and black oxide. Elimination of such processes may free up space usable for a different project.

Direct Metallization: The electroless copper process, used to achieve connections between circuit patterns on each side of a circuit board and between inner layer patterns of multilayered boards, uses some hazardous chemicals, namely chelated copper and formaldehyde. Direct Metallization replaces electroless copper in the PCB manufacturing. There are several types of Direct Metallization processes, including carbon based, palladium based, and conductive polymer based systems. The environmental advantages of changing to one of these processes may include elimination of formaldehyde, reduction of chelated copper waste, and conservation of process water. Other potential advantages include higher throughput due to a conveyORIZED process.

II-C DECREASE AMOUNT OF DRAG-OUT

II-C1. Operate Bath at Lower End of Manufacturer's Suggested Concentration

Chemical process baths have a manufacturer's recommended concentration range in which they are effective. By maintaining baths at the lower end of the concentration range, the concentration of drag-out is reduced and the life of rinsewater is extended, thereby reducing wastewater. In the case of a static rinse, change out is less frequent. For a running rinse, the flow can be reduced.

II-C2. Increased Bath Temperatures

Increasing bath operating temperature lowers both the viscosity and the surface tension of a solution, thus reducing drag-out at an increased energy expense. To make up evaporative water losses, static drag-out tank concentrate or a spray rinse above the process tank can be used. Increased bath temperatures cause chemicals to be more reactive, thus enabling use of lower concentrations.

II-C3. Drip Bars

Maximizing drip/drain time for all baths will significantly decrease the amount of drag-out. Workpiece drainage depends on the operator. The time allowed for drainage can be inadequate if the operator rushes to remove the workpiece rack from the process bath and place it in the next tank. Installation and use of a bar or rail above the process tank to hang the plated workpiece will ensure that adequate drainage time is provided prior to rinsing. Although increased drainage time can have some negative effects due to drying, some baths are not affected. Rinsing over heated baths with oversprays or foggers will allow workpieces to hang longer without drying. Maximizing drip/drain time is one of the most cost effective pollution reduction methods available.

II-C4. Slower Workpiece Removal

The faster an item is removed from the process bath, the thicker the film on the workpiece surface and the greater the drag-out volume will be. **The effect of slower workpiece removal is so significant, that it is believed that most of the time allowed for withdrawal and drainage of a rack should be used for withdrawal only.** However, when workpieces are removed from a process bath manually, it is difficult to control the speed at which they are withdrawn. Nevertheless, supervisors and management should emphasize to process line operators that workpieces should be withdrawn slowly and incorporate this into the process operation instructions.

At plants that operate automatic hoist lines, hoists should be adjusted to remove the workpiece racks at the slowest possible rate while maintaining product quality. Slow removal is more effective than additional drainage time.

II-C5. Workpiece Orientation

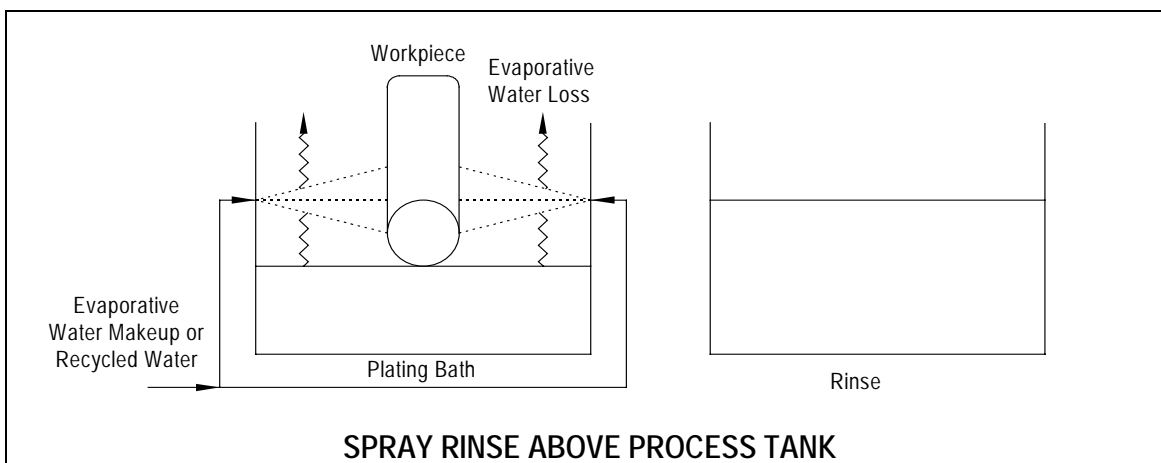
The amount of drag-out loss is affected by the shape and size of a workpiece and its position in the rack holder. Although the optimum workpiece position is best found experimentally, the following guidelines were found to be effective:

- Orient the major flat surfaces as close to vertical as possible.

- Rack with the longer dimension of the workpiece horizontal.
- Rack with the lower edge tilted from the horizontal so that the runoff is from a corner rather than an entire edge.
- Shaking or vibration of a rack may dislodge drag-out adhering to a workpiece after removal from process baths.

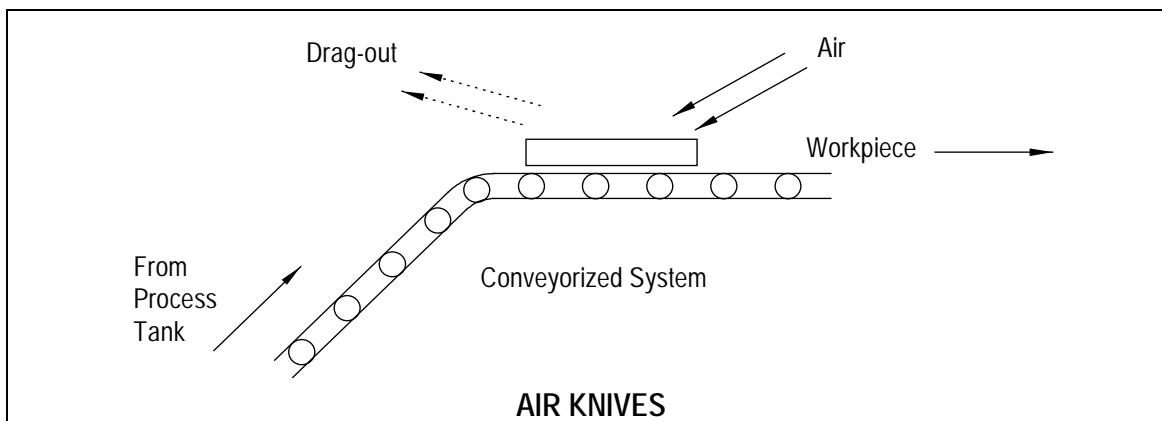
II-C6. Spray Rinses Over Process Tanks

A spray rinse can be used above a process tank kept at an elevated temperature to make up evaporative water losses while recovering bath solution. The spray rinses must be adjusted to control water makeup rate. Application of water as spray droplets or fine mist onto the workpieces above the process tank improves drainage recovery of drag-out.



II-C7. Air Knives

In an automated, conveyORIZED process, air knives perform essentially the same function as “squeegees” do, namely to reduce workpiece drag-out by removing the layer of concentrated solution adhering to the board. An air stream is directed to blow solution off the workpiece and back into the process bath. Air knives aid in clearing solutions off the whole workpiece surface and the holes, where squeegees can not reach. Air knives are particularly useful when the bath evaporation rate is too low to accommodate the water flow that spray nozzles would add back to the tank. Drawbacks of this method include drying of the workpiece, and applicability to relatively flat workpieces only.

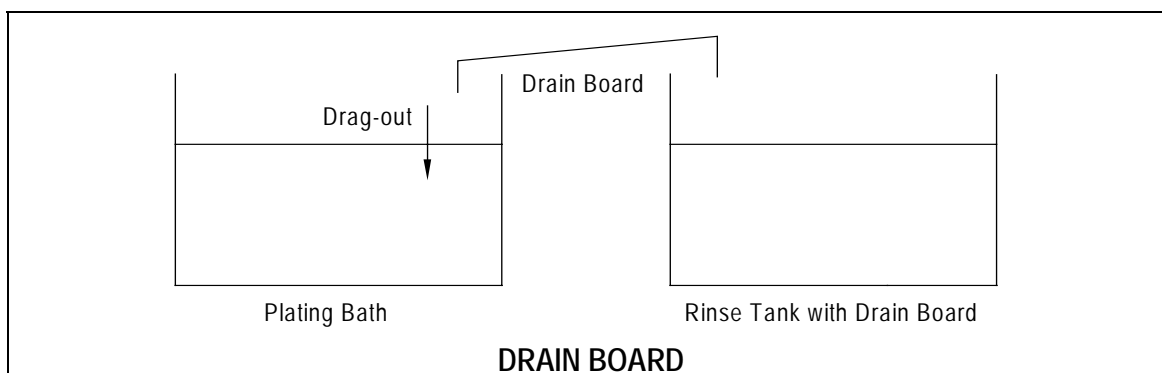


II-C8. Coated Racks

The introduction of metals into a process bath can result from parts which dissolve because of contact with process solutions. Racks are typically coated with plastic or other inert materials and minimize the amount of metals that are introduced into the bath. The use of coated racks reduces the need for stripping the conventional metal racks by reducing the metal area to be stripped.

II-C9. Drain Boards

Drain boards are the simplest method of drag-out recovery which capture drippings from racks being transferred from tank to tank. Drain boards save chemicals and reduce rinsewater requirements. The drain board should be positioned at an angle that allows the captured solution to flow by gravity back to the appropriate process tank. Drain boards should have raised edges which act as berms to prevent liquids from running off the edges.



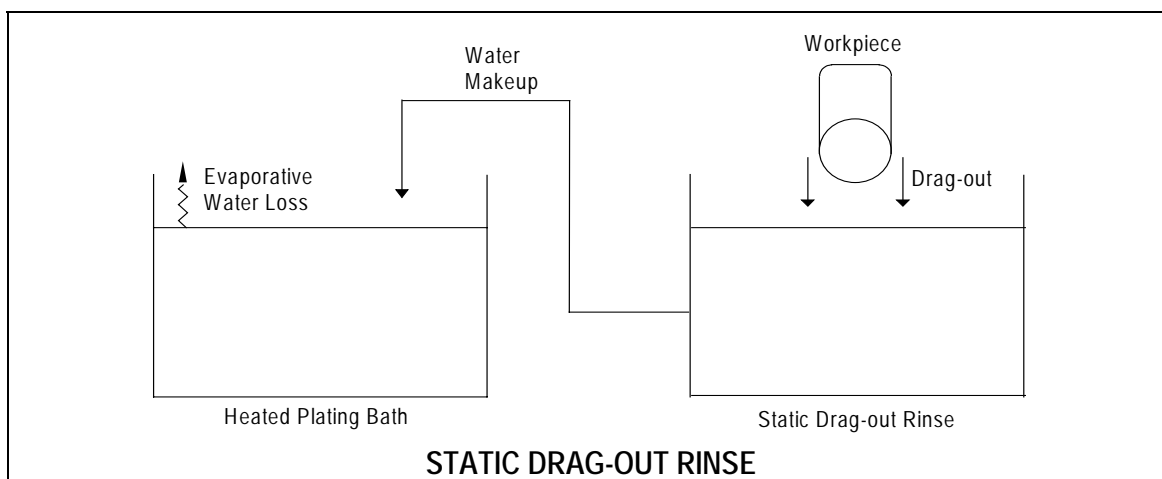
II-C10. OTHER

Use of Deionized Water: Deionized water can be used to replace tap water for process bath makeup and rinsing operations. Natural contaminants, such as carbonates and phosphates, found in tap water can reduce rinsewater efficiency, minimize the potential for drag-out recovery, shorten process bath life, and increase the frequency of process bath treatment. These contaminants also add to sludge volume when removed from wastewater during treatment.

II-D RE-USE OF DRAG-OUT SOLUTION

II-D1. Static Drag-out Rinses

Static drag-out rinses are generally used immediately after a process bath for the purpose of collecting and concentrating drag-out prior to a flowing rinse. The static drag-out rinse solution is used to replenish the process bath. High-temperature evaporative water losses can be made up by periodic addition of drag-out rinses to the process bath. Deionized water should be used for static drag-out rinse solution so that makeup water impurities are not added to process solutions. Drag-out solution from baths with low evaporative losses may be treated by evaporation and electrowinning to reduce volume and concentration prior to waste treatment.



II-D2. Heating Drag-out Tanks

Heating drag-out tanks reduce both the viscosity and the surface tension of a solution, consequently reducing drag-out. The evaporative water losses which result from heating the drag-out tank increase the concentration of the drag-out solution.

II-D3. Reuse in Process Baths

As workpieces continue to be passed through the drag-out rinse tanks, the concentration of chemicals in the tanks will increase. Drag-out solutions may be reused in the process bath where they originated.

III TREATMENT MODIFICATIONS

The most direct way to improve the quality of the effluent that is discharged to the sewer is to reduce the concentration and flow of chemicals which require waste treatment. The next most direct way to improve the quality of discharged effluent is to improve waste treatment processes. Evaluate your discharge facility as a whole, not individual process lines, using the following treatment modifications.

III-A1. Better Precipitation Chemistry

Significant improvements in reducing the volume of sludge produced and therefore disposal costs, have been reported by dischargers who changed the chemicals and flocculants used in treating wastewater streams. A variety of chemistries and polymers are available on the market. Trade associations and vendors can be a valuable resource for this type of information. Jar testing any new chemistry is essential to confirm vendors' and other claims, and to demonstrate probable compliance before attempting a full-scale trial.

III-A2. Improved Clarifier Baffles

When major cleaning, repairs, and/or maintenance activities are performed on clarifiers, it may be appropriate to replace the clarifier baffles with a better design. Improvement in clarifier efficiency has been observed at companies who modified baffles. Wastewater treatment equipment vendors and trade associations are a very valuable resource for information on new and efficient industry-specific baffle design.

III-A3. Flow Equalization for Treatment Systems

Flowrates through treatment systems should be controlled to provide a consistent flow for efficient waste treatment. Highly variable flowrates can easily "upset" clarifiers and membrane filters. Fluctuation in flow can be controlled by installing and using an equalization tank prior to the treatment system.

III-A4. Batch Treat Concentrated Solutions

All spent process baths and drag-out solutions must either be shipped off-site for recycling or disposal, or be batch treated on-site to remove the metals before the solution is further treated with the dilute rinsewater waste that has not yet been treated. This pre-treatment can be done by various methods such as electrowinning and chemical treatment. The wastewater that is left over after batch pre-treatment can then be used for

other treatment or be metered into the main rinsewater wastestream, depending upon its physical and chemical composition.

III-A5. OTHER

This section describes several non-traditional approaches to waste treatment and recovery. Although effective in the removal of heavy metals, these measures may be expensive, maintenance intensive, and effective for small flows only. Further evaluation is essential prior to implementing the following measures:

Ion exchange: Ion exchange can be used to remove metals from dilute rinse solutions. The rinsewater is passed through a series of resin beds that selectively remove cations and/or anions. As the rinsewater is passed through the bed, the resin exchanges ions with the inorganic ions such as metals in the rinsewater. The metals are removed from the resin by regenerating the resin with an acid and/or alkaline solution. The metals can be removed from the regenerant solution by using electrolytic recovery techniques, or the regenerant can simply be batch treated as a spent concentrate. The treated rinsewater is of high purity and can be returned to the process bath (though filtration of salts and/or organics may be needed for reuse), or returned to the rinse system for reuse. A common use of ion exchange for process bath recovery is for the treatment of rinsewater from a chromic acid process bath.

Electrowinning: Electrowinning is the recovery of the metallic content from high concentration solutions using the electroplating process. It is employed to recover a variety of metals, including cadmium, tin, copper, solder alloy, silver, nickel, and gold. In a typical electrowinning process, special cathodes from which the recovered metal can be stripped, are mounted in a plating tank. As the current passes from anode to cathode, the metal deposits on the cathode. This type of system generates a solid metallic deposit that can be reclaimed or sold as scrap metal. Electrolytic recovery can be performed continuously in a drag-out tank, or as a batch process on spent solutions.

Electrodialysis: Electrodialysis employs selective membranes and an electric potential as the driving force to separate positive and negative ions in the solution into two streams. To accomplish this, the rinse solution is passed through cation and anion-permeable membranes. Cation exchange membranes allow cations such as copper or nickel to pass; while anion exchange membranes pass anions such as sulfate, chloride, or cyanide. The concentrated solutions can be recycled to the plating baths, while the ion-depleted water can be recycled through the rinse system. While electrowinning is most efficient for recovering metals from concentrated solutions such as spent plating baths, electrodialysis is very effective on dilute solutions like waste rinsewaters.

Reverse Osmosis: Reverse Osmosis (R.O.) is a pressure-driven membrane separation process. The process uses a semi-permeable membrane that permits the passage of purified water while not allowing dissolved salts to pass through. The most common application of R.O. in metal finishing operations is the recovery of drag-out from nickel rinses. R.O. membranes are not suitable for solutions that have high oxidation potential such as chromic acid.

Membrane Filtration: Membrane filtration is a pressure driven cross-flow filtration process that uses a porous membrane to separate suspended solids from liquid. Once the contaminants in the wastewater have been put into a form that makes them filterable, they are removed by membrane filters. A basic filtration unit consists of a concentration tank, a process (recirculation) pump and a train of membrane modules. Indicators are provided to monitor system pressure and filtrate flow.

After chemical pretreatment is completed, the wastewater from the reaction tank is collected in the concentration tank and pumped at a high velocity through the filter membrane tubes into each membrane module. The turbulent flow, parallel to the membrane surface, produces a shearing action which minimizes deposition of solids on the membrane. Clear water, called the filtrate or permeate, filters through the membrane, and the remaining wastewater, called the concentrate and containing the suspended solids, is recirculated to the concentration tank. The filtrate flows by gravity to a filtrate neutralization system for pH adjustment before being discharged to the sanitary sewer.

IV ADMINISTRATIVE MEASURES

Source reduction efforts can be optimized by using or modifying the following commonly used administrative measures. Evaluate your discharge facility as a whole, not individual process lines, using the following administrative measures.

IV-A1. Statistical Process Control

The use of statistical process control has been applied in both the monitoring of wastewater treatment and in monitoring aqueous “plating-related” processes, although it is more common in general manufacturing. The best example of such technique is the use of process control charts (sometimes called Shewart control charts), which plot the mean and/or standard deviation of a previously determined performance variable versus time (or parts processed, or square footage) to predict trends and measure variation in the process. The desired result is a stable process that obtains maximum results with minimum materials.

IV-A2. Inventory Control

Inventory or other controls can be used to assure that chemicals in containers are completely used prior to opening a new container. The complete use of material can reduce the amount of wasted raw materials that adds to the total volume of waste. Inspecting containers before accepting them will also prevent the receipt of leaking or damaged containers which can lead to a hazardous material spill and unexpected clean up and disposal costs. Another inventory control measure is to use the materials on a first-in-first-out basis. This can reduce chances of chemicals expiring on the shelf before use.

IV-A3. Inspection/Maintenance of Facility

Inspections of the facility’s production, storage, and waste treatment facilities should be conducted regularly to identify leaks and improperly functioning equipment which may lead to waste generation. These inspections should include piping systems, storage tanks, defective racks, air agitation systems, automated flow controls, and operators’ techniques. Frequent inspections can identify problems before they become significant. Identified problems should be fixed using appropriate corrective measures. Preventative maintenance should be incorporated into the facility’s maintenance protocol. Inspections should be coordinated with the preventative maintenance schedule to reduce waste generation and improve process operating efficiency.

IV-A4. Employee Training

Educating employees on source reduction techniques and concepts will allow them to develop innovative ideas specific to your facility which may reduce disposal costs and minimize liability. Workers should be encouraged to offer source reduction suggestions. A full time, ongoing commitment to source reduction efforts must be made by owners, managers, and operators of a business. Personnel should be re-trained periodically to affirm that RCMP procedures are followed and that employees know why it is beneficial to do so. Success or results of efforts should be advertised as positive reinforcement. As new developments occur in hazardous materials management, employees should be kept informed in order for them to perform their duties more efficiently. Employee manuals should be reviewed periodically to include up-to-date information. Employee training seminars can be organized through trade associations and/or consulting firms that offer training in handling hazardous materials as part of their package of services.

Training personnel on proper withdrawal rates and the procedure for positioning workpieces on racks can help reduce the amount of drag-out that is taken from the process tanks. Since bath makeup procedures can have a major impact on the amount of waste generated, the rate of required treatment, and the ability to recycle wastewater, bath solutions should be mixed by designated and properly trained personnel. Designating a limited number of personnel to mix chemicals may improve the consistency of the baths and minimize costly mistakes.

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**Reasonable Control Measures Plan for the
Printed Circuit Board Manufacturing Industries, Metal Finishing Industries,
and Similar Businesses**

INFORMATION and IMPLEMENTATION CERTIFICATION

I certify that:

1. I am knowledgeable of the processes which generate wastewater at this facility, or that I personally supervised the preparation of this plan by someone under my authority.
2. I have authority to obligate this facility to implement the Reasonable Control Measures as submitted. I certify the plan will be implemented as described on the time schedule submitted to and approved by the City of San José Environmental Services Department (ESD).
3. I will notify the City of San José ESD in writing of any changes to the plan due to planned or unforeseen circumstances or unexpected results. I understand that any changes are subject to ESD's approval prior to implementation. I understand that any significant changes to the basis of my determinations on whether a particular RCM is applicable or not must be reported in advance of the change, where possible.
4. I certify that the information in the RCMP is true to the best of my knowledge.

Prepared By: _____
Phone _____

Signature: _____
Date _____

Name of Principal or Executive Officer Phone _____

Signature of Principal or Executive Officer Date _____

Name of Facility

Address of Facility

Address of Discharge (if different)

Industrial Discharge Permit Number